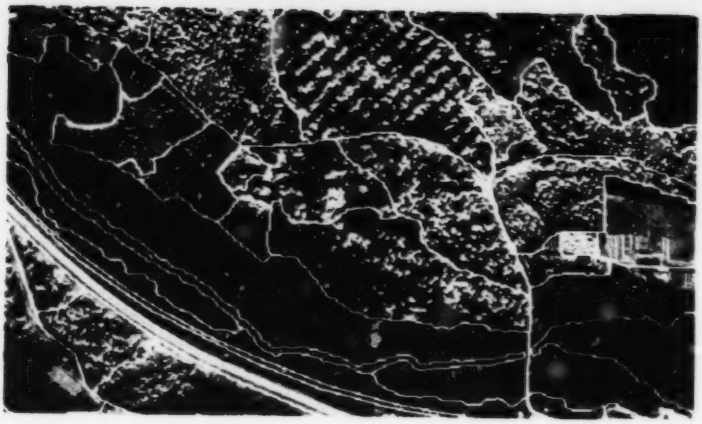
Forestry Canada Forêts Canada

PETAWAWA NATIONAL FORESTRY INSTITUTE



PROGRAM REVIEW

1988-1989

Cover photograph: MEIS image enhancement with a
GIS overlay of nursery area of PNFI (D.G. Leckie)

PETAWAWA NATIONAL FORESTRY INSTITUTE

PROGRAM REVIEW

1988-1989

PETAWAWA NATIONAL FORESTRY INSTITUTE
FORESTRY CANADA
CHALK RIVER, ONTARIO

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Forestry Canada

Forestry Canada is the main focus for forestry matters in the federal government. It provides national leadership through the development, coordination, and implementation of federal policies and programs to enhance long-term economic, social, and environmental benefits from the forest sector for Canadians.

Forestry Canada is a decentralized organization with six regions, two national research institutes, and seven regional sub-offices located across Canada. Headquarters is located in the National Capital Region in Hull, Québec.

In support of its mandate, Forestry Canada carries out the following activities:

- administers forest development agreements negotiated with the provinces
- undertakes and supports research, development, and technology transfer in forest management and utilization
- compiles, analyzes, and disseminates information about national and international forest resources and related matters
- monitors disease and insect pests in Canada's forests
- provides information, analyses, and policy advice on economics, industry, markets, and trade related to the forest sector
- promotes employment, education, and training opportunities in the forest sector
- promotes public awareness of all aspects of the forest sector.

Forestry Canada interacts regularly with provincial and territorial governments, industry, labour, universities, conservationists, and the public through such bodies as the Canadian Council of Forest Ministers, the Forest Sector Advisory Council, the Forestry Research Advisory Council of Canada, the Canadian Forest Inventory Committee, the Canadian Committee on Forest Fire Management, the Canadian Interagency Forest Fire Centre, and regional consultative committees. Forestry Canada is also active in international forestry agencies such as the International Union of

Forestry Research Organizations and the Food and Agriculture Organization, as well as in technical and trade missions.

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PREFACE

Forests play a dominant role in the social, environmental, and economic fabric of Canada and are a source of continuing wealth to the nation. Forests cover nearly half of our land mass, support a $43 billion per year forest industry, and are the source of livelihood for some 800 000 Canadians. Equally important is the role that Canada's forests play in influencing climatic conditions, water quality, and soil fertility; forests are a haven to a wide variety of wildlife and provide an escape to many people for recreation and spiritual renewal. Canada is a forest nation.

Continued prosperity from our forests depends largely or our ability to manage our use of the resource without compromising ecological integrity and diversity and without altering the capacity to renew. To this end, programs at the Petawawa National Forestry Institute are directed at using science and technology to produce technically feasible, economically viable, and environmentally sound means of forest management. Our focus is on research that is national or inter-regional in scope and which requires specialized expertise and equipment not readily available across the country. Such research is often performed in close cooperation with regional centres, provincial governments, universities, private agencies, and other federal departments. Collaborative undertakings both in Canada and internationally have provided PNFI access to a broad cross-section of experts and have enabled us to become a leader in scientific intelligence gathering and a forerunner in forest science activities.

PNFI's research is consolidated in two principal programs: Forest Management Systems and Forest Genetics and Biotechnology.

About 55 per cent of the Institute's research and development effort is directed at research in genetics and biotechnology. This program integrates projects in tree genetics, soil microbiology, micropropagation, molecular genetics, and tree seed research. Emphasis is placed on population and quantitative genetics of commercial conifers, advances in somatic embryogenesis in conifers, on establishment of conifer gene libraries, and the development of genetic engineering techniques. The seed bank opera-

tions of the National Tree Seed Centre, a long-standing project with extensive international affiliations, are included in this program. During the review period significant advances were made in tissue culture with the development of the first system in the world for successful regeneration of plants of hybrid larch from single cells; protocols for the cryopreservation of tissue cultures were developed for embryogenic systems of black spruce and hybrid larch and for an organogenic system of hybrid poplar. In the molecular genetics field researchers isolated and cloned the actin gene from black spruce (from the cDNA library), the first ever such gene to be isolated for black spruce and representing the only DNA sequence information on this species.

Other significant advances were: the development of mathematical models that permit tree breeders to make selections now versus later, based on correlations between current and future performances of trees; the creation, through a second generation controlled mating scheme in black spruce, of a number of crosses believed to be unique in forest genetics research that will provide detailed and valuable information on genetic inheritance in black spruce.

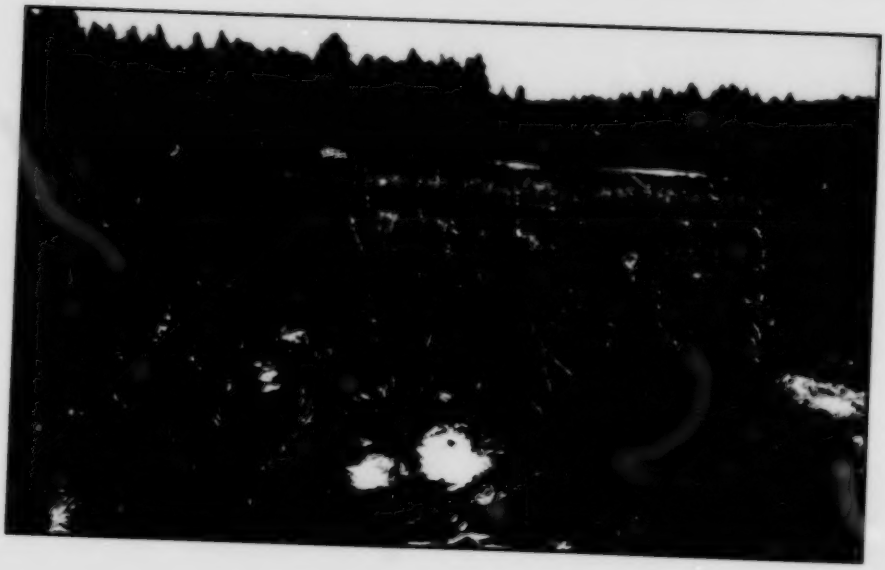
The Forest Management Systems program integrates projects in fire, remote sensing, forest modelling, silviculture, growth and yield, and pest behaviour prediction to provide research and development for the formulation and demonstration of decision support systems and forest management systems. During the review period notable advances were made in developing a turn-key prototype GIS based decisions support system for designing and evaluating stand management options in long range forest planning. A notable step in pest management systems was the development of a model based on the hemlock looper for predicting future outbreaks, spread, and impact, with the goal of managing infestations to minimize damage, plan operations, and reduce costs. The focus in fire management systems during the past year was on the development of two new expert systems: a prescribed burn planning system and the initial attack dispatch expert systems. On the silviculture side of the program dramatic early results from a plantation establishment experiment indicated early growth increases of between 7 and 350-fold for major Canadian conifers under intensive culture.

The R&D efforts of the Institute, supported by an Informatics Project group, provides the expertise and computer-based systems necessary to manage data acquired through the National Statistics Program and ongoing research projects.

PNFI research is directed to produce value-added outputs and to disseminate results through effective technology transfer. Our commitment is to enhancing Canada's competitiveness in the forest sector with complete regard for the social and environmental values of Canadians.

This booklet is designed to acquaint the reader with ongoing efforts and achievements to this end in the major programs and projects of PNFI.

A. Boyd Case
Acting Director General



CANADA
RST FOREST
RESEARCH PLOT
PREMIÈRE
PARCELLE DE RECHERCHE
FORESTIÈRE AU CANADA

Forest Genetics and Biotechnology

PROJECT PI-8

Forest Meteorology

Objectives: To conduct research relating the effects of meteorology on forestry. Present emphasis is on the potential effects of climate change on forest growth, survival, and migration.

Achievements: A review paper was published on the causes of climatic change and some potential effects of that change on forestry. A continuing review of the vast literature provides Forestry Canada with up-to-date information on the status of climate change forecasts. A paper was given on climatic classification systems at the International Institute for Applied Systems Analysis in Vienna and another paper on climate change effects on forestry in Canada at the Second North American Conference on Preparing for Climate Change in Washington, D.C.

Approximately 1000 cores from white spruce, red pine, and jack pine trees growing in plantations at PNFI are being analyzed to find climate signals. Advanced dendroclimatological techniques are being learned in preparation for more extensive climate tree-growth studies in transects across the boreal forest.

PROJECT PI-9

Tree Genetics and Breeding

Objectives: To determine the genetic basis of adaptation and productivity in forest tree species of boreal and eastern Canada; to develop procedures for more accurate assessment and selection of genetic resources in tree improvement programs; to design and assess strategies for breeding advanced generations and for deployment of genetic resources; and, to provide technical and scientific advice to agencies involved in tree improvement in Canada.

Achievements: New quantitative approaches to determine the optimum selection age in a breeding programme have been developed and the results disseminated to both the scientific community and industry.

Quantitative modelling continues to improve analytical procedures for forest genetics trials. Our latest attempts to improve quantitative analytical procedures have focused on the effects of competition and site diversity within replications upon estimates of genetic parameters.

Studies of population crosses in jack pine have been completed with the publication of a series of three papers. It is concluded that strong additive effects govern most growth traits and that hybrids, except for a slight heterosis effects, are by and large intermediate to their parents.

Isozyme analysis of mating system parameters in black spruce provenances revealed evidence of pre- and post-zygotic selection in inbred material. Selfing rates in various provenances could be related to field performance. Our results have significant implications in the evaluation of provenance field tests.

A complete update and inventory of more than 100 larch trials have been completed and the results on survival growth and yield of numerous European, Japanese, and Canadian seedlots will soon appear in an information report.

A summary of our efforts to create a weevil-resistent and frost hardy land race of Norway spruce has been compiled and presented at a IUFRO meeting in Sweden.

Training and consultation was provided in isozyme analysis and forest genetics to scientists in Thailand and other ASEAN nations as part of a CIDA seed centre project in Thailand.

Progress continues on the testing and improvement of electronic data recorders currently available in Canada. Experience and progress associated with this technology were presented to the professional community in North America.

A transfer of existing data files to a new database has been completed and we have begun the process of transferring our field maps to a GIS system with cross references to our data bases.

Distribution of seed and improved pedigreed material has continued in cooperation with provincial agencies, universities, and the private industry. Information on plantation management, data handling, seed and scion collection, and pollination techniques was exchanged through extensive consultation and collaboration with clients across North America. Coliaboration continued with foreign scientists and foresters, and project staff participated in the ASEAN-Canada seed centre project in Thailand.

PROJECT PI-10

National Tree Seed Centre, Research and Development

Objectives: To improve the quality, quantity, and effective use of tree seed for reforestation and tree improvement in Canada by researching and developing methods for increasing cone and seed yields and for storing, treating, and evaluating the quality of seed.

Achievements: A description of the effects of cone storage and prechilling on germination of apparently mature white spruce seed was published. The same study was repeated in 1988 with more variables to determine the maximum and minimum limits of favourable cone storage period.

Studies on germination requirements of black spruce from several provenances were completed. Although black spruce seed is not known to be dormant, its response to prechilling treatment is similar in many respects to dormant white spruce seed. It is hypothesized that such beneficial effects of prechilling on non-dormant seed occur through the action of a "natural repairing mechanism".

A vigour test involving application of high temperature and humidity was used for evaluating seed vigour and storage potential of white spruce, black spruce, and lodgepole pine with promising results.

Results of an 8-year survey of white spruce cone crops are being used to construct models for predicting cone crops, seed yields, and loss to insects. Future work will focus on insects in jack pine seed orchards.

Trials of gibberellin and ammonium nitrate treatments in seedling and clonal orchards of jack pine, in cooperation with Weyerhauser Canada, are providing information for developing prescriptions to improve flowering. Studies on potted 6-year-old transplants have demonstrated that nitrogen supply is a principal determinant of sexuality in jack pine and that high moisture deficits severely depress flowering. Top-pruning jack pine trees increases female flowering on lower crowns. Jack pine seedlings grown

under accelerated growth conditions produced abundant flowers and some cones in 16 months from seed.

Project personnel serve in the management team of the ASEAN-Canada Forest Tree Seed Centre in Thailand and also advise the Centre on seed technology. The CTIA Tree Seed Working Group News Bulletin is edited by a member of the project staff. Ongoing cooperative research and technical consultations with universities and industrial and provincial agencies serve as an excellent vehicle for transfer of information, for delivery of research results, and identification of problems.

PROJECT PI-11

Soil Microbiology and Tree Nutrition

Objectives: To develop and assess fertilization techniques that can enhance tree growth and survival and maintain forest site productivity. Emphasis is presently directed at developing improved container stock through controlled nutrition for use in forest regeneration programs, and at further understanding the biology of the nitrogen-fixing alder/*Frankia* symbiosis and assessing the interplanting of nitrogen-fixing species on growth of crop species.

Achievements: Nutrition experiments were completed and resulted in different seedling stock types being produced using controlled nutrition. A cooperative experiment with industry was established to assess black spruce seedling development and performance under controlled nutrition at production scales. Further understanding of actinorhizal nitrogen-fixing systems was gained. Field trials with cooperators to assess the effect of interplanting nitrogen-fixing systems on the growth and development of crop species and on soil nitrogen turnover were monitored. Isolation of *Frankia* from soils collected from across Canada is ongoing and isolates are being characterized.

A combination of tree-ring analysis and soil sampling in the Petawawa white spruce plantations revealed that growth decline is due to reduced availability of both soil nitrogen and carbon. Height growth was related to soil calcium and pH, suggesting that the soil acidification trend in the spruce plantations noted by other researchers is reducing site quality. Studies on populations and activity of nitrogen-fixing bacteria in soil and decaying wood are continuing.

PROJECT PI-17

National Tree Seed Centre, Seed Bank and Services

Objectives: To operate the Canadian Forestry Service Seed Bank and provide the national and international forestry community with well-documented seed for research purposes; to carry out customized seed collection, processing, and regulatory and service testing; to provide information on seed availability and the technology of seed management and storage; and, to collect and compile national seed statistics.

Achievements: The National Tree Seed Bank has continued to develop and improve its services by expanding and upgrading seed storage facilities. Two old cold rooms and a deep frozen chamber were replaced with two new deep freezing walk-ins for long term seed storage. The Bank procured 193 seedlots of 32 species of coniferous and broadleaved species from within Canada, and from sources in Asia, Europe, and South America. Of these, 54 lots were collected by project staff. An updated seed list is being compiled for release soon.

In response to 153 requests for seeds for research, 848 seed samples of 153 species were dispatched to clients in Canada and 17 other countries. Approximately 50 requests for information on seed availability, seed dealers, processing, testing, storage, equipment, and material, etc. were received and answered.

The seed testing service provided over 1300 tests for germination, 1000-seed weight, and moisture content determination for in-house projects. The Seed Extraction Plant processed 646 lots of 17 species from rough cones to clean seeds, and recleaned and reconditioned 285 lots of stored seeds for the Seed Bank and other PNFI projects and their cooperators.

PROJECT PI-18

Molecular Genetics and Plant Tissue Culture

Objectives: To use the new technologies of plant cell and tissue culture, molecular genetics, and genetic engineering to study the gene structure, expression, and modification of tree species; to evaluate and use these technologies in forestry; and to attempt to integrate this work in tree improvement programs.

Achievements: Research on somatic embryogenesis in conifers progressed dramatically. Routine protocols have been established for initiation of embryogenic callous from immature seeds of two *Larix* species and their reciprocal hybrids, and from mature seeds of black, white, and red spruce. The genotype effect on initiation frequency of embryogenic callus has been studied in 20 families of black spruce. High frequency maturation and germination of somatic embryos have been achieved in hybrid larch and black spruce. Somatic embryo-derived plants of these species have been established in soil and transferred to the nursery. Protoplast systems leading to the regeneration of plants have been developed for hybrid larch and are being used for genetic transformation experiments. Cryopreservation procedures for long term storage of embryogenic calli and cell suspensions of hybrid larch and black spruce have been developed. Plants have been regenerated from thawed tissues and are now in the nursery. Somatic embryogenesis is the first step to applications in molecular genetics studies and also toward the development of artificial seeds.

Genomic libraries have been constructed for black spruce, white spruce, jack pine, and hybrid larch. cDNA libraries of various stages of seed germination have been constructed for black spruce and jack pine. These libraries are currently being screened for actin and cab genes and they are used to isolate germination-specific genes. Techniques for these achievements have been developed for tree species. These tools will be used for evolutionary studies and for evaluation of individual trees.

A major effort is currently underway to genetically transform hybrid larch (*Larix eurolepis*) and hybrid poplars (*Populus deltoides* x *nigra* and *Populus nigra* x *maximowiczii*) with *Agrobacterium* or direct DNA transfer methods.

There is collaboration with Institut de la Recherche Agronomique (Orleans, France) to share complementary expertise and to avoid duplication of work between the two Institutes.

PROJECT PI-60

Plant Propagation

Objectives: To operate and manage all propagation facilities at the Institute; to provide Forestry Canada projects and outside cooperators with propagated material; to provide others with advice and assistance on various aspects of plant propagation; and, to develop and improve the propagation facilities and expertise at PNFI.

Achievements: Pedigreed material was produced for research projects at the Institute as well as other outside establishments. High quality propagules were grown in modernized controlled environment facilities. They included several thousand spruce, larch, and pine grafts, tens of thousands of containerized seedlings, as well as large quantities of bareroot seedlings.

A proposal for long term nursery soil management was prepared after the University of Toronto completed an extensive soil analysis. A soil fertility improvement program was completed.

Construction of a new five-compartment research greenhouse was initiated. This 200 m^2 facility will reflect state-of-the-art technology and efficiency in all respects. It will include control systems capable of providing totally automated management of environmental conditions.

The nursery improvement includes installation of a standby generator to provide protection against frequent power failures in the breeding halls. The new steel water intake pipe and a new pump house will bring the irrigation system up-to-date.

Technology Transfer and Operations

PROJECT PI-5

Fire Equipment, Products, and Methods–Development, Standards, Evaluation, and Technology Transfer

Objectives: To provide direction to forestry agencies and commercial industry in the standardization of forest fire suppression equipment, products, and methods; to promote technology development, evaluation, and transfer of fire suppression equipment and products; to establish and maintain liaison with Canadian and international agencies involved in technology and development in the field of forest fire suppression; to develop and maintain national forest fire statistics and technical information databases.

Achievements: Actively participated in several forest fire suppression meetings and workshops. Contributed as an advisor to the United States National Wildfire Coordinating Group, Fire Equipment Working Team and as a member of the Task Group for International/Interagency Foams and Applications Systems; assisted in organizing and presented information at "International Workshop on Foam Applications for Wildland and Urban Fire Management", Denver, Colorado, June 1988; undertook a lead role in the organization of the joint meeting of the NWCG, Fire Equipment Working Team and the CCFFM, Forest Fire Equipment Subcommittee held at Quebec City, October, 1988; participated in the Earthquake Preparedness Workshop sponsored by Emergency Preparedness Canada, Arnprior, Ontario, Sept. 1988; participated in the Canadian Interagency Forest Fire Centre, Resource Management Working Group, annual meeting, Winnipeg, Nov. 1988; participated in the OMNR Ignition Specialists Meeting, Sault Ste. Marie, Nov. 1988; contributed to the "Workshop on Fire Foam Suppressants" held at Northern Forestry Centre, Edmonton, Nov. 1988.

Work progressed in the development and/or completion of several national forest fire suppression equipment standards through active participation in the following standards organizations: Underwriters' Laboratories of Canada; Canadian General Standards Board; Canadian Standards Association; and the FFES Task Group on Forest Fire Equipment Specifications. Progress was also achieved in the following areas: laser

ignition, foam equipment development, Terra Torch, and forestry fire hose and pump development.

The project is responsible for the Canadian content in the newsletter "Foam Applications For Wildland & Urban Fire Management" of which five issues were published in 1988-89.

PROJECT PI-13

Special Projects and Technology Transfer

Objectives: To identify, coordinate, and report on present, potential, and proposed technology transfer activities at PNFI; to develop a technology transfer plan for PNFI; to develop contacts and implement technology transfer priorities with various clients using innovative and effective techniques; to carry out special projects to support and enhance the management of PNFI, including planning.

Achievements: Fostering and expanding visits of technical and professional visitors to the Institute was taken as a prime means of transfer of PNFI technology to the operational sphere. Such interchange also provides the Institute with access to current problems in the national resource field and encourages research that meet these problems.

This project is involved with the planning of the 1990 IUFRO World Conference to be held in Montreal, as well as with the planning of Forest Research Marketplace '89 to be held in Toronto in November 1989.

Skills development and training projects were coordinated by PI-13 in collaboration with the federal department of Employment and Immigration and several other government departments.

Contacts have been developed and utilized with CPPA Forest Management Group, provincial resource management agencies, and universities and colleges.

Program planning for the Institute was done by this project.

PROJECT PI-14

Public Awareness

Objectives: To promote better management of Canada's forest resources by increasing public awareness of the forest resource and the need for its sound, rational management through the development of interpretive educational and information projects.

Achievements: The on-site education project for school pupils, in formal operation since 1977, has undergone extensive evolution and revision and continues to operate successfully.

The experience of the on-site education program has been utilized in developing a forest management education project by OMNR and PNFI under the Canada-Ontario Forest Resource Development Agreement.

Draft material was pilot tested in autumn 1988. Marketing of the final product will begin with workshop leader training sessions in November 1989.

Another development in the education initiative was EDUFOR '89, a national workshop that brought together members of the education community and the forest sector to share ideas and concerns and develop a network that will facilitate further improvements in forest resource education.

Silvilog '88 in Beauce County, Québec was a huge success, particularly in terms of numbers of attendees; plans for Silvilog '90, in Nova Scotia, are well underway.

The Interpretation project has been strengthened by the dedication of .6 person years to it, but it still suffers from a lack of human resources.

The sign shop has grown to become a graphics production unit capable of producing a wide range of signage, exhibits, poster displays, illustrations, silk screens, dry transfer images, and graphics camera work.

Assignments are completed to fill the needs of research projects and administration as well as communications.

PROJECT PI-15

Library Services

Objectives: To provide library services designed to meet current and future information needs of all PNFI staff in fields pertinent to the objectives and work of the Institute through the selection, acquisition, organization, and dissemination of informational materials; to enhance the image of the Institute by providing library services to non-PNFI users, provided this does not interfere with the quality of service given to the primary users; in collaboration with the other Forestry Canada librarians, to coordinate Forestry Canada-wide library services and develop policies in support of the national forestry collection.

Achievements: The circulation module of the Sydney Library Automation System was implement in July. Two updates of the system were received, the latest of which was installed in January. Public access to the inquiry module of Sydney was provided in February and two seminars instructing PNFI staff on its use were well attended. The system continues to perform well and has greatly improved the speed and quality of library operations. The PNFI Library currently represents Forestry Canada libraries on the Sydney Users' Group of Ottawa-Hull.

The Library again reported its serial holdings to the Union List of Scientific Serials in Canadian Libraries. Eight library accessions lists and a revised serials list were produced and distributed. Online access to CCINFOLINE, the database of the Canadian Centre for Occupational Health and Safety, was obtained.

A 'Bibliography/Liste des Publications 1986-87' was compiled and published in collaboration with Editing and Publications (PI-24).

A highly active level of library service was maintained.

PROJECT PI-20

FIDS Technology Development

Objectives: To develop, manage, and support new technologies such as the FIDSINFOBASE information system and the Forest Insect and Disease Survey (FIDS) geographic information system; to investigate new technologies that can be used in FIDS and forest pest management operations for information processing; to test, develop and apply these new technologies; to investigate and develop applications towards survey design, pest condition analysis, and forecasting; to adapt these technologies to meet information needs of Forestry Canada for monitoring and evaluation of activities within forest resource development agreements. PI-20 will be known from April, 1989 as Pest Management Systems in recognition of its broadening responsibilities.

Achievements: The second version of the FIDSINFOBASE system was completed and put into operational use with the six Forestry Canada FIDS regional units. The system manages both historical and current FIDS sampling form data, insect and disease catalogues, parasite data, plot data of the Acid Rain National Early Warning System, datasets in support of pest depletion estimation, and pest impact plot data. Development continues for inclusion of other important FIDS data, such as insect and disease conditions.

Geographic information systems, based on the PC ARC/INFO software, are now installed at four regional FIDS units. These systems are used for display of survey locations, generation of an infestation map database, and for spatial analysis of infestations with other thematic map data.

The pest depletion estimation system uses FIDSINFOBASE and GIS for combining infestation maps with forest inventory data and growth loss and mortality factors. The system was operated in support of the national depletion estimation exercise.

The hemlock looper prediction modelling study, in cooperation with ESSA Ltd., the Newfoundland Forestry Centre, the province of Newfoundland, and the forest industry, is about half complete. A large amount of environmental and pest research data has been assembled for analysis and model building. This study will determine current data capabilities in supporting prediction systems.

An agreement for exchange of information technology was formalized through the North American Forestry Commission in order to promote the cooperative development of decision-support systems with the USDA Forest Service.

A new study was formed to develop an information system for forest resource development agreements using the project's expertise in database technology. A survey of Forestry Canada headquarters and regional information needs and data availability for monitoring the agreements was completed.

PROJECT PI-21

Petawawa Research Forest (PRF)

Objectives: To integrate the management of forest resources of the PRF; to provide timber disposal and forestry services to CFB Petawawa and AECL; to enhance the understanding of forest management applications; and, to provide field services to PNFI.

Achievements: Forest management consisted of silvicultural treatments to 82 ha using $20 800 allotted under COFRDA, monitoring forest fire activity at PNFI and CFB Petawawa, application of insect and disease control measures, and harvesting 4350 m^3 of timber (worth $44 000) in support of research activities.

Timber disposal from forest lands at CFB Petawawa realized 49 722 m^3, worth $956 000. A management plan was developed for the AECL property at Chalk River. This effort was funded under COFRDA.

A biomass burner was built by Sylva Energy Systems Ltd., Thunder Bay. The burner will consume approximately 400 green tonnes of slash which would otherwise be burnt in brush piles.

Public awareness activities centered around Silvilog '88 in Québec, the Sugar Bush, tours of the Headquarters Silvicultural Area, and the forest. Field services activities continued to provide numerous services ranging from office moves to silvicultural and infrastructure improvement.

PROJECT PI-54

Forest Inventory

Objectives: To provide a national focus for forest inventory matters, and to facilitate at all levels the exchange and use of information and data; to develop and promote good practices and procedures for forest inventory; and, to develop, maintain, and use Canada's Forest Inventory and related information.

Achievements: The project continued participation in inventory-related liaison activities, especially through the Canadian Forest Inventory Committee (CFIC), the US-Canada Forest Assessment Technology Exchange (FATE), Forestry Canada's Forstats Committee, and the federal Inter-agency Committee on Geomatics (IACG).

Hosted two visiting scholars from China for one year, and presented two papers at international meetings.

In cooperation with CFIC and Forestry Canada headquarters completed the third edition (now bilingual) of "Forest Inventory Terms in Canada", and had it authorized as a departmental standard. Also produced the first CFIC/PNFI Joint Publication.

Completed a survey of compilation procedures in Canadian forest management inventories and reported on the dangers of calculating change from successive static inventories.

Continued cooperative work with the Digital Remote Sensing Project (PI-16) to apply satellite and MEIS imagery to monitoring for forest inventory.

Completed, with cooperators, a pilot project to map forest cover types from very small scale satellite imagery.

Publicized to a wide audience "Canada's Forest Inventory 1986", and the services available for its use.

Answered a steadily increasing number of Canadian Forest Resource Data System (CFRDS) client requests for information and maps not covered in the main reports. Continued to upgrade the capabilities of CFRDS, and began planning the acquisition of new forest inventory data in 1991.

Continued cooperation with several agencies to combine national inventory data with other studies and data sets (eg. acid rain, forest pests, and national wood supply).

PROJECT PI-31

Management Services

Objectives: To provide an administrative control system and fiscal accountability in accordance with statutory and regulatory requirements; to provide general administrative services including purchasing and matériel management, records management, accommodation services, office services, and fleet management; to operate and maintain the physical plant; to manage PNFI construction projects.

Achievements: Construction of a second floor over the Header House has been completed with the installation of three new environmental growth chambers. In addition, the soils laboratory was totally renovated. New walk-in freezers were installed at the National Tree Seed Centre, Seed Bank and Services area. The nursery received new cold frames for propagation research. A new fire tower was installed on the Montgomery range. The nursery and propagation facilities received a telephone and security alarm system. A railway crossing signal system was installed at our main crossing, definitely a measure for enhanced health and safety. A chemical store was established and a complete inventory of all chemicals conducted. Many buildings were sealed to eliminate the annual fly problems and conserve heat. The receptionist and finance offices were totally renovated. A high voltage substation, including single phase protection, has been installed in the physical plant to upgrade the hydro facilities. This significantly lowers the danger element from the boiler room. A three million BTU biomass burner was installed; this will greatly lower oil heating costs. Many other projects were carried to improve and enhance the physical plant and property in support of the research.

The stores and supplies operation are undergoing review and simplified methods are presently being installed. The disposal of unwanted material will follow. The motor vehicle garage is continuing to update equipment and engage in up-to-date courses for moderate engine analysis. House 59 in the residential section of PNFI was refurbished and upgraded as a VIP visitor accommodation centre. The newly established Forestry

Canada Publications Distribution Centre is operating at capacity; extensive renovations were carried out to accommodate this facility.

Forest Management Systems

PROJECT PI-4

Fire Behaviour and Effects

Objectives: To expand the Canadian Forest Fire Danger Rating System to yield estimates of fire spread rate and intensity in various important forest and fuel types; to apply meteorological techniques for predicting lightning fire occurrence, fire danger rating, and the impact of potential climate change on fire severity; to study intense behaviour of both accidental and prescribed fires; to describe the ecological role of fire in natural forests and the basis of its use as prescribed fire in forest management; and, to develop methods of measuring the impact of fire on forest age-class distribution and timber supply.

Achievements: The equation system for the Fire Behaviour Prediction System was expanded to include means of estimating crown foliar moisture content from location and date, two submodels of the mechanism of fire crowning, and a complete scheme for combining wind and slope vectors for estimating spread rate. The whole system has been tested and adjusted to provide an acceptable match with the extensive field derived database.

On the meteorological side, a study of interpolation methods for fire danger rating should enable fire control agencies to have a better understanding of the fire danger between weather stations. As well, the relation of meteorological variables to monthly provincial area burned by wildfire in Canada 1953-80 was investigated. This study showed that area burned was related to blocking ridges in the upper atmosphere. Also, a study on the impact of potential climate change on the severity of the fire season was initiated.

Work on fire ecology dealt with the use of fire as one option, the other being cutting, in the management of aspen. Research showed that spring burning under leafless aspen results in progressive mortality of trees due to girdling by fire. Root nutrient and energy reserves become exhausted over a two-year period, precluding vegetative reproduction through suckering. Cutting, as expected, caused prolific suckering. Cooperative research in the interior of B.C., dealing with nutrient use efficiency of seedlings

grown on various site preparation treatments continued, with a first set of destructive sampling and ongoing chemical analyses carried out by the Pacific Forestry Centre.

PROJECT PI-6

Forest Fire Management Systems

Objectives: To research, develop, and integrate appropriate new decision making, computer, artificial intelligence, and remote sensing technologies into the daily operation of Canadian fire management agencies.

Achievements: Four large expert systems are under various stages of development and testing. The initial attack dispatch expert system determines the best combination of waterbombers, crews, and helicopters to send to a newly reported fire. It classifies the fire situation and determines the best acceptable response, using two embedded dynamic programming optimising algorithms controlled by a large set of Prolog-coded rules. It has been field tested at Maniwaki, Que., and at Thunder Bay, Ont. for the past two fire seasons. At Thunder Bay where the program is supported by a real-time resource inventory, the program is proving to be very effective. At Maniwaki, without such inventory support, dispatchers find the expert system's data entry too time consuming. For 1990, a real-time inventory system will be available to solve this problem.

The fire occurrence expert systems predicts the daily occurrence of lightning and people-caused fires. It uses fuzzy logic, advanced computer graphics, and a means for entering expert human spatial perceptions. Some 2000 Prolog-coded rules dealing with various fire causes and likely fire behaviour are executed for about 500 geographic cells. The system will be field tested during 1989 at both Maniwaki and Thunder Bay.

Development of a third expert system has just reached the field test stage. This system is designed to position bombers, crews, and helicopters at satellite bases on a daily bases given the anticipated fire situation. It uses Prolog-coded rules with embedded linear and stochastic dynamic programming algorithms to determine the number, location, and zone of operations for each resource type. It also determines the number of each type that is required to meet the anticipated fire situation. This system will undergo initial field trials at Maniwaki, Qué., Thunder Bay, Ont., and Victoria, B.C. during the 1989 field season.

A fourth expert system is presently under development for prescribed burn planning, based on procedures and experience of the B.C. Forest Service. It will assist the user through the planning process, compare objectives and likely effects, and suggest a fire weather prescription and strategy for ignition and control.

PROJECT PI-7

Fire Suppression Systems

Objectives: To research and evaluate ground and aerial forest fire suppression systems and techniques; to determine the impact of field conditions on suppression effectiveness; and to advise fire management agencies on suppression-related matters.

Achievements: The use of forest fire-fighting foam continued to increase in Canada and so has the need to address concerns related to product characteristics, methods of application, effectiveness under various field conditions, and product specifications. Studies were carried out in response to client needs, and laboratory experiments were initiated to better understand the foam's role as a fire suppressant.

A lichen moisture code was developed to help assess hazard levels in these fuels, as moisture content is the prime influencing factor determining ease of fire suppression in such fuels. Rain wets different fuel species at different rates and even the same species can be wetted at different rates depending on the degree of curing. A study has been initiated to quantify the rates of wetting of suppressants and retardants under various field conditions and to relate this phenomenon to suppression effectiveness and needs.

PROJECT PI-12

Silviculture and Forest Productivity

Objectives: To develop a quantitative framework for the application of silviculture in Canada based on an improved understanding of the underlying biological mechanisms. Specific areas of research include the environmental control of plantation establishment, the evaluation of plantation establishment, the evaluation of plantation performance, and the process of intraspecific competition in the development of conifer plantations.

Achievements: Research continued on a major field study examining the effect of soil temperature, vegetation competition, and nutrient availability on plantation establishment. This experiment, consisting of similar plantations in the Great Lakes-St. Lawrence forest region (Chalk River, Ontario), the Boreal forest region (near Timmins, Ontario), and the Sub-Boreal Spruce forest region (near Prince George, British Columbia) has been monitored for environmental conditions and tree growth over three growing seasons. Each plantation uses local spruce and pine species and uses micrometeorology, growth analysis, and morphological/biochemical analysis to interpret how changes in environment control seedling productivity. Several workshops and publications were produced from the results of this study.

In a study of plantation assessment technology a prototype system for assessing free-growing status of plantations was field tested by the B.C. Ministry of Forests. An interface between the model's output and the B.C. Ministry of Forests Inventory Branch Geographic Information System was written using PAMAP software. This work was published and presented at symposia. A model of the dynamics of red pine plantations was developed in association with Dr. Steen Magnussen (PI-9). This model predicts the dynamics of size distribution as a function of coefficients that describe the sharing of resources among individual trees of different stature in the plantation.

PROJECT PI-16

Digital Remote Sensing

Objectives: To research, develop, and transfer to the forestry community practical methods of extracting information on the state of Canada's forests from imaging satellite and airborne sensor systems operating in the visual, infrared, and microwave parts of the spectrum.

Achievements: Effort has concentrated on development of forestry applications of linear array imager data. Forest inventory, particularly species identification, is a key area of interest. Enhancements of MEIS (Multispectral Electro-optical Imaging Scanner) imagery have given good species differentiation. Work on automated isolation and classification of single trees has commenced. Assessment of forest damage is also an important application and cooperative studies on spruce budworm damage assessment are continuing. Design parameters for an advanced linear array imager for forestry applications have been specified. The capabilities of a stereo MEIS imager for tree and stand height estimation is being tested.

An investigation into the capabilities of combined radar and visible infrared imagery has been completed. It indicated the advantages of combining these data sources for forest type mapping. Investigations into satellite change detection are continuing and winter and spring satellite imagery shows good potential for conifer regrowth assessment. The project operates a powerful image analysis system, and software upgrades to the system have been developed and implemented. The project is undertaking surveys of the procedures for forest inventory map production and inventory update used in Canada.

PROJECT PI-19

Forest Management Modelling

Objectives: To review, evaluate, test, or modify existing forest management models; to develop a comprehensive forest management model; to integrate Geographic Information Systems (GIS) and databases with forest management models; to undertake basic research in forest mensuration and stand modelling.

Achievements: An integrated forest management model was developed in cooperation with the Ontario Ministry of Natural Resources and Abitibi-Price Inc. This model is being used to test a number of different management scenarios as part of the Forest Management Agreement (FMA) planning process. Output includes detailed maps showing treatments for individual forest stands. The FIRFOR model is being used as a teaching tool at three universities.

A new taper function has been developed that allows for the continuous variation in form along the tree stem. The function can predict upper stem diameters and stem volumes more accurately than most existing taper functions.

Informatics

PROJECT PI-40

Informatics Program

Objectives: To provide PNFI research and administrative programs with software support, database support, system support, Electronic Data Processing (EDP) consulting support, and text processing; to provide EDP and communications technical assistance, give direction and standards for using computing technologies, and provide administrative support for Treasury Board and Departmental EDP policies.

Achievements: Provided computing support to other programs at PNFI and Forestry Canada headquarters. During the past year the existing computing facilities were reviewed in consultation with the Computer Advisory Committee and a strategy for replacing the older computer hardware and software was established. Further information on projects in the Program will be found under entries for PI-41, PI-42, PI-43, and PI-44.

PROJECT PI-41

Wordprocessing

Objectives: To provide PNFI with a flexible and efficient text processing service.

Achievements: The two members of the wordprocessing group have been using the VAX wordprocessor, the DECMATE wordprocessor, and the AES wordprocessor to provide a flexible text processing service for a staff of 134 at PNFI including scientists, management, and support staff. Scientific papers, meeting minutes, purchase orders, contracts, and staff performance reports were among the wide variety of document processed.

PROJECT PI-42

Database Systems

Objectives: To provide computer service for supporting and managing databases at PNFI; to plan, develop, and implement database systems in support of research and administrative programs as well as to provide database consulting support and training.

Achievements: Database Systems modified and upgraded scientific databases and completed an information survey of all the databases at PNFI. In addition, the project provided database support for administration by supporting the Material Management Information System, the Sydney Library System, Corporate Mailing List (CORPMAIL), and the Minister's Correspondence Tracking System.

PROJECT PI-43

Computer Systems

Objectives: To provide PNFI with a facility for computation, information storage and retrieval, and image analysis. The project provides technical support for hardware, software, communications, and EDP security.

Achievements: Computer Systems has principal responsibility for two multi-user VAX computer systems and financial responsibility for three other VAX computers and associated equipment. This project maintains a computer network of more than 140 terminals, printers, and microcomputers as well as two Datapac links into the Forestry Canada national communications network. During the past year the data communications systems at PNFI were reorganized, improving service and reducing costs by 60%.

PROJECT PI-44

Software Services

Objectives: To provide PNFI with general support for application development, software development, systems analysis, geographic information systems, statistical analysis, software maintenance, and software training; to evaluate and implement software, provide software consulting, and microcomputer evaluation and support.

Achievements: The project responded to more than 30 clients and over 400 requests for support and/or services, including the programming of information products, analysis, training, demonstrations to visitors, preparation of literature, and documentation. As well, the project evaluated new software, microcomputers, printers, and local area networks.

Other Services

PROJECT PI-22

Information Services

Objectives: To project and enhance the image of the Institute and the role of Forestry Canada to various publics; to develop, wherever possible, linkages to other agencies in and outside of the forestry sector for delivery of Institute scientific and technical programs; to manage a program of hosting visiting delegations.

Achievements: The Institute continues to receive thousands of visitors annually and Information Services works cooperatively with respective hosts to plan and manage these visits. An increasing number of conferences and symposia, many at an international level, were successfully conducted at the Institute. Delegations visited from around the world, as well as from throughout Canada and the U.S.A.

The role of Secretary to the Organizing Committee of the IUFRO World Congress was undertaken and will demand nearly full time attention by Information Services personnel to sometime beyond the 1990 event. As well, the Chairmanship of the Publicity and Promotions committee has been assumed, so as to conceive and deliver a global campaign about the IUFRO World Congress, Canada's largest forestry meeting to date. These tasks involve constant networking with virtually every forestry agency and the forestry industry across North America. Constant interface with forest science agencies around the world is being maintained to heighten awareness of the Congress.

Information Services completed the Christmas Tree Video project in time for Christmas 1988. Professional quality bilingual video materials were distributed to the media and key figures in the industry as well as cooperating growers' associations. The videos met with a very favourable response.

PROJECT PI-24

Editing and Publications Services

Objectives: To publish reports and scientific papers that disseminate collected statistics and the results of research undertaken by the Institute; to promote among the general public an understanding of forest research and sound forest management by preparing and producing a newsletter, leaflets, etc. that describe the work of the Institute; to ensure that the Institute conforms to Federal bilingual requirements; to manage the Forestry Canada National Publications Distribution Centre; to store and protect Forestry Canada national technical scientific archives; to collate submission of Forestry Canada scientific and technical publications to microfiche publishers.

Achievements: A total of 78 contributions to the scientific literature were contributed by PNFI authors during fiscal year 1987-1988. These included articles in international journals, published proceedings of symposia, and PI-X series information reports in both French and English.

The Corel Desktop Publishing System has revolutionized production of papers in that we now have instant access to sophisticated formatting capabilities and a variety of type sizes and faces. The latest software has been purchased, as well as a ROM optical disk and a turbo drive for the laser printer. Costs are reduced because there is no more need to use commercial typesetters.

A local printing firm is engaged under a DSS standing offer agreement to print all PI-X series information reports. The advantages of this arrangement have including discounted printing costs, faster turnaround, and better quality control. The relationship with Queen's Printer, CFB Petawawa continues.

Distribution of Forestry Canada publications is being done through a contractor. A sophisticated, semi-automated mailing operation has been set up, resulting in significant cost savings.

Collation and archiving of all Forestry Canada scientific and technical documents continued. The microfiching of all Forestry Canada scientific and technical publications was coordinated by the project and the work is progressing well.

Project personnel published an annotated bibliography of PNFI publications in partnership with PI-15 (Library Services). The involvement of the project with the ASEAN-Canada Forest Tree Seed Centre will present further interesting challenges.

PROJECT PI-70

Personnel

Objectives: To provide personnel generalist services to management and employees covering staffing, classification, staff relations, training, human resource management, pay and benefits, employment equity, official languages, and health and safety.

Achievements: Coordinated staffing of vacant positions throughout the year and advised managers of changes in the staffing process. Hired 30 students under Challenge '88. Recommended ratings for positions, advised management in the writing of Performance Analysis Schedules, and the use of classification standards. Provided ongoing service to management and staff on staff relations, monitored new cases and precedents being set, and handled employee grievances. Assisted employees in the area of pay and benefits. Coordinated training needs of employees, and developed an annual training plan.

The project participated in the PNFI Health and Safety Committee, Management Committee, and the Union Management Consultation Committee, and provided advice as required. Management and employees were advised on language identification of positions, language training, and testing. Assisted management in ensuring policies were followed by PNFI that were consistent with employment equity guidelines. A Human Resources Plan was developed for PNFI. Assistance was provided in the preparation of appraisals and monitoring of these documents to identify training needs.

PETAWAWA NATIONAL FORESTRY INSTITUTE
EXPENDITURES 1988-1989
($'000)

Program area	Person years	Salaries	Operations & maintenance	Capital	Grants & contributions	Total
Management and administration	27	1 122.3	1 164.4	1 877.5	–	4 164.2
Forestry data systems (Informatics)	12	499.8	376.7	117.7	–	994.2
Forest management systems	30	1 325.0	210.2	164.2	–	1 699.4
Technology transfer and operations	30.5	1 345.5	297.4	11.1	–	1 654.0
Forest genetics & biotechnology	35	1 475.0	460.1	170.6	–	2 105.7
Total	134.5	5 767.6	2 508.8	2 341.1		10 617.5

SCIENTIFIC CONTRACTS OVER $5000, 1988-1989

CONTRACTOR	SCIENTIFIC AUTHORITY	PROJECT TITLE	AMOUNT
University of Toronto	Dr. D.M. Burgess	The development of high yield willows for energy production by interspecific hybridization.	24 996.00
Weyerhaeuser Canada Ltd.	Dr. D.M. Burgess	Study of effects of interplanting sitka alder with lodgepole pine.	7 789.00
C. Ward	Dr. W.M. Cheliak	Cryobiology to develop protocols for storing embryogenic callus cultures of black spruce and hybrid larch.	7 000.00
A. Rodick	Dr. J.B. Harrington	To obtain dendrochronological data in order to determine the climatic signal by finding the past effect of climate on tree growth so as to infer the effect of future climatic warming.	19 425.00
E. McLeod	Dr. O.Q. Hendrickson	Nutrient analysis of alders.	23 000.00
S. D'Eon	J.M. Power	Develop operational FIDS database.	14 385.00
L. Clark	Dr. T.J.B. Boyle	Identification of embryos and gametophytes.	9 000.00

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1988-1989

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Forest Resource Officer	W.R. Clark B.Sc.F.

PROJECTS

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Silviculture and Forest Productivity (Project PI-12)	D.G. Brand (Project Leader) M. Penner R.P.F., B.Sc.F., Ph.D. G. Brand D.J. McGuire (retired May 1989) C. Robinson
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Forest Management Modelling (Project PI-19)	R.M. Newnham B.Sc., M.F., Ph.D. (Project Leader) I.S. Alemdag For. Eng., M.F., Ph.D. (retired October 1988) G. Larocque B.Sc.A., M.ès.Sc. T.G.E. Moore B.Sc.F., M.Sc. C.G. Lockwood

TECHNOLOGY TRANSFER AND OPERATIONS

Program Director	A.B. Case B.Sc.F., M.Sc.F.
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Special Projects and Technology Transfer (Project PI-13)	D.J. Stewart R.P.F., B.Sc.F. (Project Leader)
Public Awareness (Project PI-14)	J.J. Williams (Project Leader) J. Vaillancourt
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Management Services (Project PI-31)	H. Rohde (Manager, Management Services) W. Levasseur (Contracts Officer) T. Kasaboski (Materiel Management) R. Davies J. Patterson S. Lamontagne (Senior Stationary Engineer) D.C. Houde S. O'Reilly W. Rodd C.E. Wilson B. Wyatt (Construction Foreman) K. Griffiths (Mechanic Supervisor) J. Davis R. Gohr E. Kulas

FOREST GENETICS AND BIOTECHNOLOGY

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National Tree Seed Centre, Seed Bank and Services (Project PI-17)	B.S.P. Wang B.Sc.F., M.F. (Project Leader) B. Kelley B.Sc. E. Gilchrist
Molecular Genetics and Plant Tissue Culture (Project PI-18)	W.M. Cheliak B.Sc.F., M.Sc., Ph.D. (Project Leader) F.M. Tremblay M.A.Sc., Ph.D. P.J. Charest Ph.D. K. Klimaszewska M.Sc., Ph.D. J. Pitel B.Sc. L. Deverno B.Sc. Hons. J.R. Lavereau

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Program Director	J. Partridge B.Sc.
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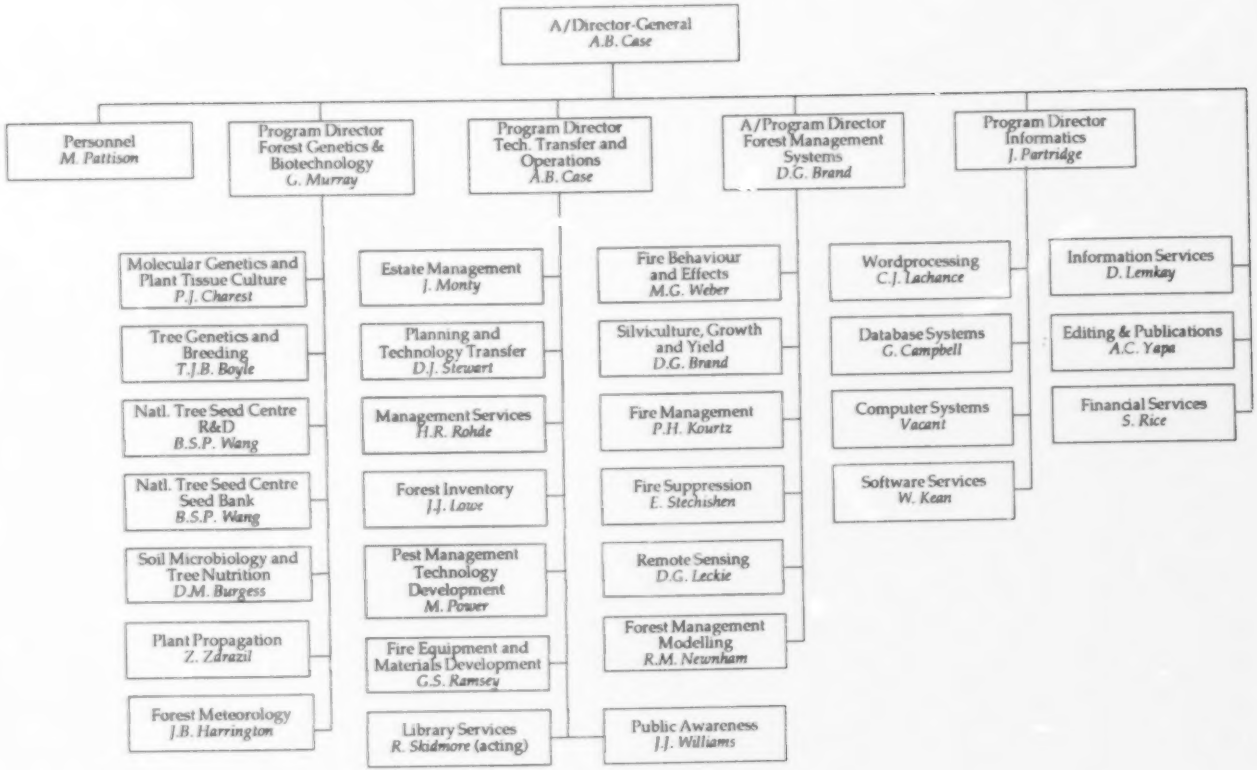

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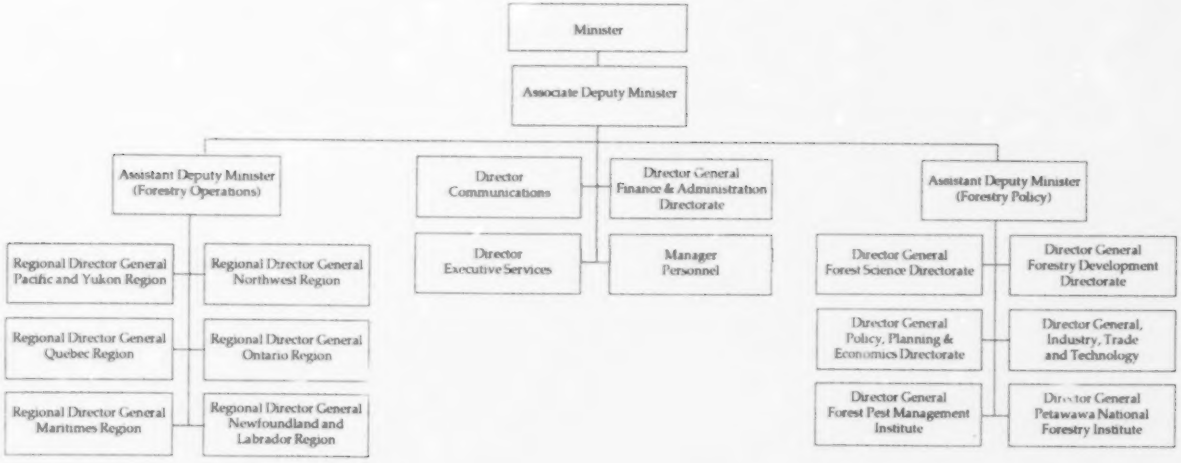
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Assistant Deputy Minister (Forestry Operations)
Director Communications
Director General Finance & Administration Directorate
Director Executive Services
Manager Personnel
Assistant Deputy Minister (Forestry Policy)
Regional Director General Pacific and Yukon Region
Regional Director General Northwest Region
Regional Director General Quebec Region
Regional Director General Ontario Region
Regional Director General Maritimes Region
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